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ABSTRACT

Information is provided for projects on metric education involving the use of motor vehicles or vans as mobile laboratories or demonstration units. Included are various types and functions of mobile education facilities in common use in recent years in both mathematics and non-mathematics areas, with descriptions of several current metric mobile units. Possible applications for the mobile metric units are listed as teacher inservice training, student familiarity and demonstration, and awareness information for the general public. Facilities, equipment, and possible display items relevant to the various uses of the units and the various metric measurement topics are also discussed. A suggested checklist for use in selecting, designing, and operating mobile metric education laboratories is given in the Appendix. (MN)

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GUIDELINES FOR DEVELOPMENT AND USE OF MOBILE METRIC EDUCATION LABORATORIES

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

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Edwin M. Carr
Susan G. Hanson
Louis Sokol

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Special note should also be made of the contributions of Mr. Jimmie Don Hester, Science Curriculum Coordinator of the Memphis Board of Education and Ms. M. LaVern Lawson of the Hancock County Board of Education, Sparta, Georgia.

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I. INTRODUCTION

The use of a motor vehicle or van as a mobile laboratory or demonstration unit is not a new concept. Various types of mobile vans have been in use for many years as a medium of information dissemination in all parts of the country and for varying purposes. A recent variation is their use in connection with metric education. As part of the Metric Education Technical Support Program, the American Institutes for Research has reviewed present and past applications of mobile teaching and information centers in an effort to establish some guidelines for other projects that are interested in pursuing this method of metric education and promotion. Availability of such guidelines would inject a certain degree of standardization, and it would reduce the duplication of effort which would necessarily take place in the absence of any guidelines.

The guidelines in this report have not only taken into consideration the successes and shortcomings of past projects, but they have relied heavily on past expertise acquired in the teaching of the nation's new measurement language, the International System of Units, or SI.

The two major advantages of a mobile metric demonstration unit over a fixed facility are that it permits the reaching of a much larger target audience, because it can move to many different locations and, under most circumstances, that it is cheaper to move a mobile unit to a distant location than it is to assemble many persons from distant locations at one fixed place. The major disadvantages of a mobile unit are its potentially high initial cost and its limited size for demonstrations and for hosting an audience.

In spite of these disadvantages, a mobile metric unit has a great potential for metric education and the possibility of its use should be fully explored by projects, states, or other organizations assigned the responsibility of promulgating the metric message. A decision by any organization to undertake the development of a mobile metric unit can only be made after all the factors relating to its acquisition and operation have been thoroughly explored.

II. OVERVIEW OF MOBILE EDUCATIONAL FACILITIES

In general, three types of mobile educational facilities are in common use today. They are

1. The commercially available recreation vehicle, usually refitted inside as required.
2. The converted transit line or school bus.
3. The completely custom-built unit with a purchased chassis as the foundation.

A fourth type, less commonly used, is the "semi" trailer and tractor rig, with interiors separated into usually two sections, a classroom and a laboratory or shop area.

The three common types will be discussed in some detail, the fourth only briefly.

Commercially Available Recreation Vehicle

The recreation vehicle (RV) is available in countless sizes and configurations and from many different manufacturers. The RV can be the motor home type, complete with self-contained propulsion, or the trailer type which can be transported with a standard-sized automobile or pick-up truck. It is difficult to estimate prices of such units since they can be purchased either fully equipped as motorized homes or with stripped interiors for custom installation, the latter being, of course, the better choice of the two for use as a vehicle for educational purposes.

It would be unusual for a commercial RV dealer to exhibit much interest in providing a custom-designed interior because, as a rule, such a dealer wants to accomplish a rapid turnover of stock vehicles at the greatest profit with the least time and effort expended. To be considered, also, is the fact that ready-made interior units, such as shelves, cabinets, and tables, are not necessarily adaptable to the requirements of the educational objectives. Fortunately, the demand for custom units has led to the existence, nation-wide,

of small cabinet shops which specialize in made-to-order RV interior units with a wide choice of materials available. It should be recognized, however, that the structure of the RV may preclude alterations without extensive rebuilding.

One advantage of the RV is that one does not need a special driver's license to operate the vehicle. The average driver should be able to efficiently and safely handle an RV with a minimum of practice.

Converted Transit or School Bus

The converted bus should be given serious consideration because of the possibility of low initial cost. For instance, a school district in the San Francisco Bay Area purchased a surplus U.S. Navy bus several years ago for fifty dollars, and with $2000 worth of paneling (metal exterior, wood interior), interior carpeting, paint, and repairs, developed a mobile art display van that has been most successful and has operated with a minimum of maintenance. This cost, however, did not include interior cabinet work, other than wall paneling, since none was needed for the purpose.

One disadvantage of the converted school bus is the low gas mileage--one source reported 2 km/l (5 miles/gallon). Ordinary maintenance should present little or no problem, since most school districts already operate a school bus system, with attendant maintenance facilities, either provided by the district or contracted to a local garage.

Completely Custom-Built Unit

The custom-built unit, constructed on a purchased chassis, presents the optimum in choice of vehicle design, since it can be designed from the chassis up with complete specifications for each aspect of the vehicle written into the bid for construction. This type of unit can be designed to fit every objective of the program within, of course, the financial limitations of the program. The cost of such a unit could fall within a range of 25-50 thousand dollars, or more, depending upon vehicle specifications and program equipment installed.

Putting a custom-built unit into operation requires more lead time than other units discussed previously. The objectives of the program, to a large extent, dictate the design of the vehicle; objectives, therefore, are the first order of business. The specifications of the vehicle must then be decided upon in detail to facilitate the process of contractor bidding. By the time objectives are developed, vehicle specifications are written, bidding completed, a contract signed, staffing completed, and the vehicle delivered, one can be well into the second half of a one-year project before the vehicle goes out for its first operation. The extensive lead time and cost are probably the major disadvantages of the custom-built vehicle.

The fourth type of unit, the "semi" trailer and tractor rig, would be advantageous only if a full classroom situation is desired. This type of vehicle presents problems of parking, storage when not in use, and maintenance as well as initial expense. The operators of such a vehicle must be specially trained and possess a special driver's license (a special license is usually not required for the two-axle vehicles described previously; it would, however, be wise to check with the state department of motor vehicles on this matter).

III. EXAMPLES OF MOBILE TEACHING FACILITIES IN NON-MATH AREAS

This section is intended to provide specific examples of mobile vans used in the past several years. A variety of vehicles have been used for quite diverse purposes.

A. Arkansas: In 1970, the state of Arkansas began using a traveling machine-shop training facility housed in a 3.7 metre by 18.3 metre, four-axle trailer, custom designed for the purpose (Burnett, 1972).

Somewhat resembling a mobile home, the unit weighs in excess of 2.3 metric tons and, except for restroom and electrical facilities, is self contained. The forward half is designed to hold 20 students and an instructor in a desk-equipped classroom. The desks convert to drafting tables when needed. Chairs, chalkboards, slide projector, and storage facilities are also included. The lab portion in the rear half contains 10 lathes and 10 milling machines.

Additional units include a second machine shop, an electronics shop, a building trades shop, and a refrigeration and air conditioning shop. The cost of these units is about $30,000 each, but the state of Arkansas has found the cost/benefit ratio far superior to conventional facilities.

B. Massachusetts: Project MODEL (Mobile Occupational Development Education Laboratories) is an experimental program designed to provide career education for the handicapped and disadvantaged and placement in jobs or other educational environments after instruction (Warzecha and Naughton, 1975).

MODEL is housed in four mobile units, one of which is devoted entirely to vocational assessment; the other three provide students with the opportunity to perform on-the-job tasks with on-the-job tools. Each student works at his/her own pace, supported and directed by highly specialized audio-visual equipment, instructional programs, and two instructors.

C. Washington: When the purchase of a custom unit for a mobile supermarket cashier/checker training program proved financially prohibitive, Washington State negotiated with a vocational-technical institute, through its regular instructional classes, to convert a trailer unit into a classroom. The state was responsible for blueprints, plans, and cost of materials. Through well planned publicity, the project received donations of a used trailer and tractor and $15,000 in cash to cover costs of materials and equipment (Logan, 1971).

The plans included space for three split "L" checkstands, a table and chairs for a group of 12 students, and storage facilities. Wiring, paneling, flooring, and heating and air conditioning facilities were also included in the plans.

The unit has not only been used for training new personnel but also for upgrading already employed supermarket personnel. Like other mobile units, the trailer has reached out to isolated areas of the state to provide students with equal opportunities for training and employment and to provide industry with a source of already trained personnel.

D. California

Burlingame School District: A mobile art education project began in 1970 with an old 8.2 metre length U.S. Navy bus acquired for $50. The seats were removed and a new look was given to the vehicle including external metal paneling, an additional rear door, carpets, curtains, electrical outlets, display lights, new paint, and audio equipment. The refurbishing cost in the neighborhood of $2,000. Very little storage space was included since the entire internal area was needed for exhibit space. Learning experiences involving all the senses are presented for school children.

Local museums, historical and ethnic groups, and industries have been highly cooperative in assisting with exhibit planning and providing materials for exhibits and demonstrations.

San Mateo County: The San Mateo County library system has operated a highly successful bookmobile program for the past 10 years. While the purpose of the program is not solely educational in nature, the operational aspects are similar to those of any mobile unit.

The program presently employs two part-time drivers. Finding substitute bus drivers is difficult and having two part-time drivers is advantageous since they can substitute for each other in case of emergencies. The driver also is trained to check books into and out of the traveling library. The driver's seat swivels and a desk is placed so that when the seat is turned it can double as a desk chair when the unit is on-site.

For reliable maintenance, one year contracts are given to an outside agency. Cooperation with the maintenance company is thus ensured and often permits the program to have the services of one reliable repairman in an emergency. Past experience has shown that, if a breakdown occurs while on the road, it is advisable to leave the vehicle in a safe place, where it can stay until repairs can be made, due to the difficulties of towing this size vehicle. Maintenance costs average about $1,700 per year for each of two units.

One problem encountered has been that of ventilation in the summer months. Because of safety hazards, fans have not been used to alleviate this problem, even though proper ventilation is necessary to store phonograph records, films, and tapes. When the units were created, multimedia materials were not commonly available through libraries and adequate storage space and climatic control were not planned for.

Another unforeseen problem has been that of a slight safety hazard in the choice of floor covering. The units were designed with linoleum floor covering which have proven to be slippery in contact with wet shoe soles. Carpeting would have been more desirable, even considering the higher cost.

San Mateo County Dental Society: Instituted in March 1971, the "brushmobile" has served an impressive 90,000 children. Sponsored by the San Mateo County Dental Society, this mobile preventive dentistry unit is equipped with facilities for both tooth-brushing instruction and audiovisual education. Originally purchased for $1,000, this recycled, 50-passenger school bus has been completely reconstructed. The cost of the reconstruction of this bus was approximately $9,000 and the yearly cost of operation, including salary, insurance, maintenance, supplies, and AV materials, runs about $10,000. Sixteen drinking fountains, each with a mirror and a stereophonic headset, replace the rows of seats on the bus. The brushmobile has air conditioning as well as heating facilities and, because the water and waste systems are self-contained, the only power requirement is an external 110-volt supply.

It is interesting to note that, in contrast to other programs, this program employs only one person, the driver-educator. This person is a certified school teacher with the courage to drive a bus. Scheduling of the bus is handled directly with each district or school by a secretary in one of the local dental offices. A cover letter is sent to the principal telling him/her that a level spot within 50 feet of an outlet will be needed for the bus and asking him/her for two volunteers. The mobile operator feels that it is a great advantage over and above that of economy to ask for volunteers at each site for the volunteers' enthusiasm is normally higher than regular staff, and the fact that one person is clearly in charge prevents problems.

Like other mobile units, ventilation has been a problem of great concern on the brushmobile. Not only do the metal roofs found on buses absorb a great deal of heat, but the heat from electrical equipment and human bodies also adds to the need for adequate climatic control.

IV. MOBILE MATHEMATICS LABORATORIES

A. Project Vanguard (State University of New York at Buffalo)

Sponsored by the National Science Foundation, Project Vanguard is housed in an 8.5 metre, self-contained mobile unit (a converted "camping trailer") and is essentially a traveling class and resource room for teachers, K-8. The unit, according to the project brochure, contains the largest elementary mathematics curriculum library available to teachers in western New York.

The unit contains audiovisual equipment including a video tape projector, study carrels, curriculum development materials, and current commercial materials including manipulatives, catalogs, and publications. An "Introducing the Metric System" unit is included.

Twenty key personnel of over ten school districts in western New York and five college faculty members were trained as resource people and workshop leaders to provide inservice training to some 3,000 teachers in the Vanguard operational area.

B. Montana Math Mobile (Montana Council of Teachers of Mathematics)

With the assistance of funds from the National Council of Teachers of Mathematics (NCTM), the Montana Council of Teachers of Mathematics (MCTM) rented and equipped a 6.4 metre trailer to transport a mathematics teaching center to teachers in the large, sparsely populated state.

The trailer was remodeled to contain bookshelves and storage areas along the side and rear walls, and a full-width desk with two-drawer file cabinets on either side in the front space. A wide assortment of manipulatives, resource books, student reading materials, and duplicable materials across all levels are available. Some low-cost materials are also available for teachers to purchase.

The Math Mobile visits school districts during the regular school year and university campuses during the summer months. Teachers in the local school districts play an active role in the operation of the

Math Mobile. Availability is announced periodically in the MCTM newsletter. Based on requests by teachers, the program coordinator plans the schedule for an entire school year. Individual teachers are then chosen in each district to take responsibility for managing the mobile in that locality. The local teacher is then expected to

- make arrangements to move the mobile from the previous site
- publicize the appearance of the mobile
- arrange an evening workshop to acquaint colleagues with the mobile resources (the workshop is usually presented by an MCTM member)
- arrange to have the mobile unit available at various hours at a central location
- appoint personnel to check out the materials available, and
- collect payments for items sold through the Math Mobile

The most enthusiastic response to the mobile has come from the smaller community school districts. The large school districts usually have access to the type of materials available in the Math Mobile; the teachers from the smaller districts, however, are eager to avail themselves of the materials to which they might not otherwise have access.

V. CURRENT METRIC MOBILE UNITS

A. Memphis Board of Education

As part of the Memphis project funded by the USOE Metric Education Program, the interior of a 7.3 metre length Winnebago motor coach with a 2-metre head clearance (already owned by the Board) was altered to provide a public awareness demonstration and activity unit. The unit was parked at department store entrances and shopping centers on Saturdays during May and June of 1977. The initial appearance of the unit was publicized by local television that evening.

Among the exhibits and activities inside the van were:

- translucent, backlighted charts illustrating the basic SI units
- large map outlines of Alabama, Mississippi, and Tennessee, the Southeastern United States, the United States, and Memphis, with distances between major cities and localities labeled in kilometres
- a comparison chart of miles per hour versus kilometres per hour and miles per gallon versus kilometres per litre
- a display of some 40 highly diverse products, with dual labeling, purchased in Memphis
- a variety of hand-lettered posters with slogans such as:

  DON'T GET LOST - FOLLOW THE LITRE
  DON'T BLOW YOUR TOP - KEEP COOL WITH CELSIUS
  BE PREPARED TO MEET YOUR METRE
  TAKE A LOAD OFF - WEIGH IN KILOGRAMS
  METRICS IS HERE NOW! BE A METRIC BUYER
  DON'T BE PETRIFIED - BE METRIFIED

- a 24-question metric matching quiz with a flashing light indicating a correct answer
- a double-pan balance with stacking mass pieces with which visitors could determine the mass of items on their persons.

Outside the van passersby were urged to stop long enough to determine their mass on a metric bathroom scale and their height in centimetres with a 2-metre measuring tape on the side of the van.

Personnel involved in the activities the first day were a high school science teacher, eight volunteer high school students serving in morning and afternoon shifts (four each shift), and the project director, Jimmie Don Hester. In later appearances, the science teacher served as coordinator of the exhibit and van driver on a salaried basis.

An attractive, informative commercial brochure on the metric system was also distributed to interested observers. On the first day of operation more than 1,300 of these brochures were distributed. It was planned to distribute some 22,000 during the course of this phase of the project (Hester, J. D., Personal communication, 1977).

B. Hancock County Board of Education (Sparta, Georgia)

A Dodge Tradesman 200 van, purchased new, with custom carpeted floor, serves as the mobile unit for this project, funded by the USOE Metric Education Program. The unit is used primarily to transport workshop materials, although in exceptional circumstances simple workshops can be held in the vehicle. The major disadvantages in this case are small interior area and low head clearance. In-van activities must be done during daylight hours due to lack of any means of connection to an outside source of electricity other than an extension cord strung out of the door of the vehicle.

The target audience of the Sparta van is a group of parents of students in the Hancock County Public Schools. Materials are transported to the residences of participants in the program, where one-hour workshops are held in the home. Four retired school teachers have been trained in the metric system and in conducting workshops. All four persons go out on each scheduled trip with one of the four acting as driver on each trip. The driver drops the other three off with workshop materials and then proceeds to a fourth home in an area for the fourth workshop. Schedules are set up for two days per week. The parents thus trained will serve as community resource personnel in subsequent years (Lawson, M. L., Personal communication, 1977).

C. San Diego County Department of Education (California)

Funded originally by Title III (now Title IV-C) of the Elementary and Secondary Education Act, the San Diego County Department of Education has, for the past three years, been operating the "METRIC MOBILE," a teacher-training mobile facility, which travels to schools in an area about equivalent to the state of Connecticut. Mr. James Lawson was the director of this project.

Mr. Ron Andrade, in a report written for the USOE Metric Education Program titled "METRIC (SI) EDUCATION AND THE USE OF MOBILE INSTRUCTIONAL SERVICES" (1976), describes the San Diego County program and delineates points to be considered in the decision to use a van and the design of the van. The "METRIC MOBILE" serves almost exclusively as a medium for inservice teacher training. The vehicle is not designed to accommodate children, since it has only one door (California state law requires two doors if children are in the vehicle).

According to Andrade, the two major criteria to be considered in the expenditure for a van are that the program will operate in a large geographical area and that the duration of the program will be greater than two or three years. Andrade also points out that

> Programs designed to offer support services through the use of mobile vehicles may find that program efficiency in direct service areas can be increased, and that several audiences may be reached that would be difficult to contact otherwise. Because the level of service may be increased, a net reduction in proposed personnel may result. The savings gained in personnel alone might warrant the selection and use of a mobile vehicle.

Some of the possible metric education functions of a mobile unit, as suggested by Andrade, are to provide:

1. Expertise, materials, and manipulatives for group "hands-on" workshop experiences
2. Collection, storage, and display of prepared lessons and materials
3. Expertise, media, and equipment for large or small group informational or awareness presentations
4. Specific expensive materials on loan for formal materials analysis

5. Resource files for research information, materials acquisition, and current metric information

6. Publicity for metric conversion through community demonstration and display of the mobile unit

7. Instructional media software and hardware for preview and review of metric instructional media

8. Limited production capabilities (audio-tape, transparencies, lamination) in support of training sessions

9. Facilities for the collection and reduction of evaluation data in support of program evaluation goals

10. Facilities for the collection, sorting, and distribution of program materials

11. A field office for program personnel

Anyone seriously considering the use of a mobile unit in metric instruction should review the vehicle design details contained in the Andrade report.

VI. POSSIBLE APPLICATIONS FOR MOBILE METRIC INSTRUCTIONAL LABORATORIES

Mobile units can be designed to serve any one or all of the following main types of applications for metric education programs.

- Teacher inservice training with hands-on experience
- Student familiarization or demonstrations
- Awareness information to the general public

A. Teacher Inservice Training

Only a minority of the nation's teachers have any familiarity with SI and the ability and willingness to teach it to their students. Traditionally, the major responsibility of teaching measurement concepts has been assigned to the areas of mathematics and science. However, all subject areas entail some use of measurement units and therefore all teachers need metric orientation aside from the fact that they are consumers.

Basically, no teacher should be asked to teach a subject with which he or she is unfamiliar, and in most cases teachers will hesitate to teach a subject about which they know little or nothing. For this reason, a major task confronting the nation is to teach the teachers the basics of metric measurement before they can go to their classes and teach their students. The easiest way to bring this about is through the inservice training of teachers in the necessary metric measurement knowledge they need in order to develop the ability and confidence it takes to pass on that information to children.

Mobile metric laboratories are one means by which the inservice training of teachers can be accomplished. The design of such a unit should take into consideration the requirements for inservice training of teachers including provision for adequate hands-on experience. The latter is very important, since a "feel" or "familiarity" with a new measurement language can only be achieved through actual measurement and computation activities.

B. Student Familiarization or Demonstrations

Presently, many of the nation's schools lack the facilities and materials necessary to teach the metric system. For such students, a mobile metric van offers them the opportunity to observe such metric measuring equipment even though there is, in most cases, a limit on their opportunity to actually measure with such equipment due to space and time limitations.

C. Public Information Services

A major task confronting the United States is to inform its people on the need and desirability of completing the task of metrication which up to this point has been led by a number of major companies and some educators. The country is going metric, and there is no use in denying or backing away from this fact.

The task of informing the public on the need to go metric as well as showing them the few main metric units and how to use them is formidable. It must be done in order to allay their fears and reduce the opportunity for the development of public resistance as has been the experience in Britain. The cooperation and support of the general public, many of whom have children in schools, is important from the standpoint of educators, since it will assure the community support needed for any new teaching project or concept.

There is no good reason why a mobile metric van for educational purposes cannot be so designed that it can also serve the general public, particularly at times when it would not be in educational use. Generally, these times would be on weekends, evenings, and during vacation periods. Much of the equipment needed for this purpose would already be available for the teacher inservice training program and student demonstrations.

VII. SUGGESTED FACILITIES AND EQUIPMENT FOR MOBILE METRIC INSTRUCTIONAL LABORATORIES

Work Areas, Display Areas

The type of arrangements and interior facilities of a metric mobile unit will depend to a large extent on the purpose for which it is intended. These should be determined before any contracts are awarded for the custom fitting of the mobile unit interior.

Provision must be made for certain specific activities and display areas. This should include wall space for the display of charts and posters. Boards, either open or enclosed in glass, should be provided for the display of measuring equipment and other artifacts. If the mobile unit is to be used for inservice teacher training, work areas should be provided where hands-on experience can be obtained as measurement activities are engaged in.

If the mobile unit is to be used for public information service, its capability can be increased if a large section of the right side of the vehicle opens up along a horizontal hinge placed high on the side. Such an adaptation allows for a large number of people to stand outside and observe metric demonstrations presented from the interior of the vehicle. The extended side offers protection of the display from rain or the sun. It is often appropriate to use audio-visual equipment, such as 16 mm sound-motion picture projectors or 35 mm strip-film projectors with audio-cassette units, for metric presentations. Because of the close quarters in a mobile van, these projectors are best used in combination with a front-surface mirror (set at 45^{o} to the projected light) and a rear screen (illuminated from behind) for direct viewing by the audience. The availability of a television receiver capable of playing television cassettes may also be desirable. Provision must be made for the safe stowing of the equipment when the vehicle is in transit.

With most mobile units, space limitations preclude the display of all equipment and charts at one time so provision must be made to allow for the interchange of display items. Adequate storage facilities (drawers and cabinets) are therefore essential.

A copier or transparency maker can be an asset when presenting inservice training workshops. A typical feature is a bookshelf to hold reference books and vertical file cabinets to hold reference reports and metric journals. A small chalkboard is useful for diagramming aspects of tables, listing of items, or sketching construction "plans."

All equipment which is not stowed should be adequately secured when the vehicle is in transit.

Specific equipment and material recommendations will be given under each measurement category. There are many measurements or physical quantities for which there are units in the International System of Units (SI) or modernized metric system, as it is commonly called. Of these, five are considered measurements for everyday use. These are:

LENGTH
AREA
VOLUME (including capacity)
MASS (commonly called weight)
TEMPERATURE

These are also the physical quantities which are taught in the elementary grades as part of measurement activities. All presentations, whether they are presentations to teachers, students, or the general public, should place emphasis on these five measurements. To these can be added the following with which the layperson has some occasional use in everyday living.

FORCE
PRESSURE
WORK
POWER
SPEED

The following list will give recommendations for measuring devices for each type of measurement as well as examples of actual applications. None of the measuring devices displayed should have any customary units.

LENGTH MEASUREMENT: Length is perhaps the most commonly used everyday measurement, and it is the basis from which such derived units as area and volume are developed. Display items required:

Metrestick - should be divided into centimetre and millimetre divisions with each whole centimetre numbered from 1 to 99. Enlarged numbers at each 10 cm position are desirable.

20 cm and 30 cm Rulers - scales should be marked in millimetres as well as centimetres.

150 cm Flexible Plastic Tailor's Tape

If workshops are given, sufficient numbers of the above items are desirable to allow their use by students. A body height chart should be affixed to a wall to allow measurement of body heights.

Display Samples - longer (3 or 10 metre) tapes should be made available.

Adhesive Metric Tapes - several rolls of self-adhesive metric tapes should be available for "calibrating" equipment or converting items equipped with customary scales.

Trundle Wheel - one of these is helpful for workshop sessions and can be used outside of the mobile unit for linear measurements outside of the range of centimetre rules and metresticks.

AREA MEASUREMENT:

Square Metre - a piece of durable paper or plastic which is one square metre should be available for demonstration. These preferably should be ruled off in decimetre squares.

Square Decimetre - several rigid plastic or wooden decimetre squares which are ruled off into square centimetres are desirable.

VOLUME MEASUREMENT: Volume is an important concept because so many of man's activities involve this measurement. The capacity of containers is also measured in volume units.

Cubic Metre - available for demonstrations outside of the mobile van should be a unit which can be assembled to form the outline of a cubic metre.

Decimetre Cube - several plastic and paper decimetre cubes should be available for display as well as for hands-on experience by participants. The plastic models usually permit the holding of water whose mass can be measured in demonstrations.

Centimetre Cubes and Cuisenaire Rods - should be available for display and demonstration.

Volume Measures - cylindrical-shaped measures either in the form of beakers or similar shapes which are correctly calibrated in millimetres should be available in at least the following sizes: 100 mℓ, 250 mℓ, 500 mℓ, 1 ℓ. Small measures of the spoon variety in 1 mℓ, 2 mℓ, 5 mℓ, also are desirable.

MASS MEASUREMENT: Mass is one of the most important measurement quantities since so much of man's everyday activities involves the use of mass. Considerable controversy exists in the U. S. whether to use the technically correct term "mass" or continue to use the word "weight," in spite of the fact that "weight" can mean either mass or the force of gravity.

SI does not use the word "weight." SI recognizes the quantity *mass* which is represented by the unit kilogram, and it recognizes the quantity *force* which is represented by the unit newton.

Australia and the Republic of South Africa have made a great effort to encourage the use of the terms "mass" and "force of gravity," whichever is meant, instead of the term "weight" and its derivatives. The rationale is that since a new measurement system is being introduced there is no good reason why a break with tradition cannot be totally made and the correct terms "mass" or "force of gravity" be used as required.

The same approach could well be considered by those responsible for teaching SI to teachers, students, and the public in the U. S.

Devices or instruments required:

Double Pan Balance with Set of Masspieces - is the most important device for demonstrating mass measurements. Emphasis should be made that it will function anywhere in the universe provided a gravity field is present. The mass of an object is constant irrespective of its location; however, the only practical way of measuring mass is by the utilization of the force of gravity acting on any given mass. When a double pan balance is used to measure an unknown mass the force of gravity acting on the object is made to equal that force acting on a set of known masspieces--in effect, the force of gravity is negated because it acts equally on both sides of the balance.

Spring Scale (Pan Type) - this device reacts directly to the local force of gravity. When it is calibrated in mass units against known masspieces it is a satisfactory instrument for measuring mass at that location. When its location is significantly changed either in latitude or elevation, it must again be recalibrated. A spring scale calibrated in force units, i.e., newtons, can be used anywhere in the universe. However, commercial commodities are only measured in mass units and not force units. Force units are used by design engineers when computing the resolution of forces acting on various structures.

Spring Scale (Tension Type) - samples of those with mass unit and force unit calibration should be available for demonstration purposes.

Body Scale - either a floor spring scale or medical scale should be available, so persons can measure their body mass.

Masspieces - several masses of varying sizes should be available from 1 g to 10 kg. The larger masses can be canvas money bags filled with sand and marked with their mass values.

TEMPERATURE MEASUREMENT: Temperature measurements are probably the concern of more persons than any other type of measurement. Most people use temperature measurements as a basis for determining what type of clothing to wear each day.

The most satisfactory approach for people to learn the Celsius temperature scale is to learn a few commonly referred to temperatures such as the freezing and boiling points of water rather than making comparisons to the Fahrenheit scale.

Wall Chart in form of "dummy" thermometer - a vertical chart or simulated thermometer at least 40 cm long should be posted, which is calibrated in 10 degree Celsius increments. Arrows with appropriate identification should point to the following values:

100^{o} C	Boiling point of water
37^{o} C	Normal body temperature
22^{o} C	Comfortable room temperature
0^{o} C	Freezing point of water

Several actual Celsius thermometers should be displayed, including a medical thermometer.

Only minimal emphasis should be placed on describing the following four measurements or quantities: FORCE, PRESSURE, WORK or ENERGY, POWER.

FORCE: a chart or drawing showing a hand pushing against an object can depict that a force is a "push" or a "pull."

The newton should be described:

A one-kilogram mass exerts a downward force of 9.8 newtons due to the action of gravity.

PRESSURE: a chart should depict that pressure is equal to force per unit area. In SI this is a newton per square metre (N/m^2), and this is given the name of pascal (Pa).

Show an automobile tire with the statement: 29 p.s.i. = 200 kPa.

Show that average sea level atmospheric pressure is about 100 kilopascals.

WORK or ENERGY (QUANTITY OF HEAT): on a chart depict a force of one newton acting through a distance of one metre and call this 1 joule (J) of energy. State that all forms of energy will be expressed in joules or the multiples kilojoule (kJ) and megajoule (MJ).

Depict a slice of pie and show that kilocalories will be replaced by kilojoules. It should be explained that the dieter's Calorie is actually a kilocalorie (the amount of energy in the form of heat required to raise the temperature of 1 kg of water 1° C.). One Calorie equals about 4 kilojoules.

POWER: a chart could explain that power is the time rate of doing work and that the watt (W) is the SI unit of power.

1 watt = 1 joule per second

The watt or kilowatt will be used to express all forms of power.

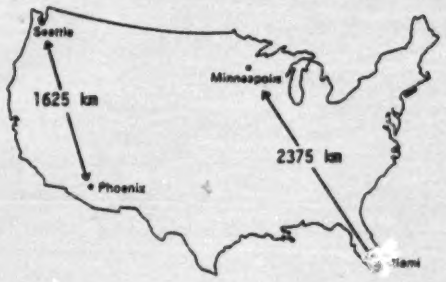
SPEED: while metre per second (m/s) is the SI unit for speed, the unit used for motor vehicle speeds and wind speeds will be the kilometre per hour (km/h).

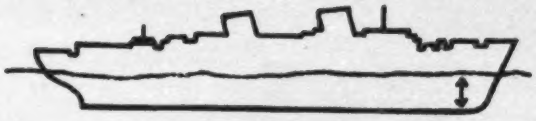
55 m.p.h. becomes 90 km/h.

POSSIBLE ITEMS FOR DISPLAY WHICH SHOW APPLICATION OF SI UNITS

LENGTH: ILLUSTRATED CHART SHOWING:

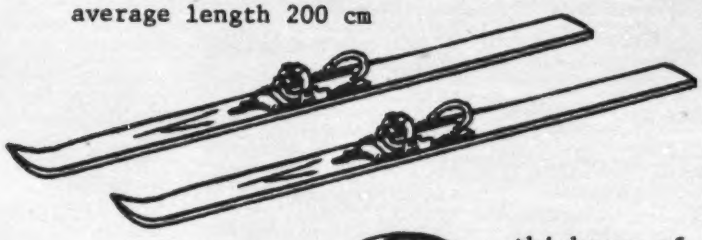
distance between cities





ships draft 95 dm

skis
average length 200 cm



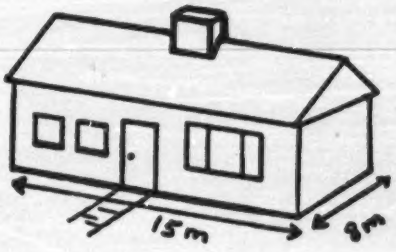
thickness of dime
1 mm

OTHER TEACHING AIDS should be available, such as ACTIVITY CARDS, METRIC SONGS, BOOKS, PAMPHLETS

GAMES: SOME POPULAR GAMES SHOULD BE AVAILABLE FOR DISPLAY--Travel Metre, Metric Football

AREA: on a chart depict:

average home
floor area 120 m^2



VOLUME: exhibit litre size soft drink bottle; prescription bottle in 50 or 100 mℓ size

MASS: exhibit aspirin tablet - 325 mg
five cent piece - 5 g
package of sugar from Canada - 1 kg

APPENDIX

Suggested Checklists for Use in Selecting and Designing Mobile Metric Education Laboratories

CHECKLIST FOR DECISION TO USE
MOBILE METRIC EDUCATION LABORATORY

1. What is the project duration of the program?

   a. One year (1)
   b. Two years (2)
   c. Three years (3)

2. What is the geographical area to be served?

   a. City (large or small) (0)
   b. County (1)
   c. State (2)

3. What is the level of funding of the program?

   a. Less than $30,000 (0)
   b. $30,000 - $50,000 (1)
   c. $50,000 - $100,000 (2)
   d. $100,000 - $200,000 (3)

4. What is the average distance target-audience individuals would have to travel to a centrally located, stationary facility?

   a. 0 - 100 kilometres (1)
   b. 100 - 200 kilometres (2)
   c. 200 - 300 kilometres (3)

5. How many persons would participate in a single program session?

   a. 1 - 4 (3)
   b. 5 - 7 (2)
   c. 7 - 10 (1)
   d More than 10 (0)

After these questions have been answered, add up the numbers in parentheses after each answer. The lowest total will be 2; the highest, 14.

It would be impossible to foresee the particular circumstances of each project considering the use of a mobile metric laboratory. If, however, the total score is 8 or above, serious consideration should be given to the use of a mobile unit.

CHECKLIST TO ASSIST IN
MOBILE UNIT DESIGN DECISIONS

1. Will unit be used for

_____ Inservice teacher training?

_____ Student education?

_____ Public awareness?

2. What will be source of unit?

_____ Custom fabrication

_____ New, stripped RV (motorized)

_____ Remodeled used RV (motorized)

_____ Remodeled school bus

_____ Trailer-type RV

3. What facilities will be required in unit?

_____ Closed, locked storage space (cabinetry or files)

_____ Level work areas

_____ Bookshelves

_____ Self-contained audio system (microphone, cassettes)

_____ Seating

_____ Electrical service (generator, outside hookup or both)

_____ Reproduction equipment

_____ Heating and air conditioning

CHECKLIST FOR MOBILE UNIT OPERATION

1. Does driver need any special training?

   _____ In use of mirrors

   _____ Maneuvering in tight situations

   _____ In minor repairs

   (1) replacement of fan and generator belts, collant hoses
   (2) installation of spare tire

2. Has a security plan been designed?

   _____ Locking of vehicle when not in use

   _____ Parking area for storage between trips or overnight at site

   _____ Lockable storage area inside van

   _____ Positive latches on all windows

   _____ Distribution of necessary keys (master or specific)

3. Has an adequate insurance coverage been implemented?

   _____ For van

   _____ For driver

   _____ For contents

   _____ For persons coming aboard

4. Publicity

   _____ Brochures to participating agencies

   _____ Newspaper

   _____ Radio - TV

5. Scheduling

_____ One person to oversee scheduling

_____ Initial phone contact

_____ Written follow-up to phone call

_____ Up-to-date schedule calendar--copy in van

_____ Time to travel between sites

_____ Down-time for routine maintenance of van

6. Parking site requirements

_____ Level surface

_____ Door opening on safe, non-traffic side

_____ Clear access for van height

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